

REMARKS

This paper responds to the Office Action mailed on October 19, 2004.

Claims 7, 8, 13, 20, 21, 28 and 34 are amended, as a result, claims 3, 5, 7-42, and 65 remain pending in this application. No new matter has been added. For example, the discontinuous seed layer may be found in the specification at least at page 8 line 13, and in Figs. 2 and 3.

§103 Rejection of the Claims

Claims 8-10, and 34-37 were rejected under 35 USC § 103(a) as being unpatentable over Tan et al. (U.S. Patent No. 6,372,622) in view of Matsuda et al. (U.S. Patent No. 6,403,481). Applicant respectfully traverses this rejection.

The Examiner's response at section 7 of the outstanding Office Action to the previous amendment and argument, states that Applicant "argues mainly that none of the applied references teaches the formation of a seed layer", and that the Examiner disagrees with this argument. Applicant does argue at least that none of the cited references, whether taken alone or in any combination, describes or suggests at least the claimed features of an electroless plating seed layer, or an electroless plating seed layer that is discontinuous, or an electroless plating seed layer that is less than 15 nm thick, or an electroless plating seed layer that has a discontinuous island structure, as recited in various ones of the embodiments of the presently claimed invention.

The Examiner specifically states that the Tan reference "clearly discloses a seed layer of Cu sputtered over a barrier layer 14 which is itself formed on a semiconductor substrate 10 (see col. 3, lines 30-53 specifically lines 43-46)." Applicant respectfully submits that the Examiner is incorrect in asserting that it "is the sputtered Cu, which is the seed layer, not the barrier layer 14, as argued by applicants", since Tan explicitly states that "the layer 14 may also include a sputtered layer of copper overlying the titanium tungsten and or titanium tungsten nitride layers to provide a seed layer for electroplating" (col. 3, lines 43-46). Applicant submits that the Tan reference does not disclose or suggest a discontinuous seed layer for electroless plating, or even a

thin layer, since to perform electroplating, as distinct from electroless plating, it is necessary to have a uniformly conductive electricity carrying layer that extends from the point of electrical attachment, typically near the edge of the wafer, to all points on the wafer. Applicant submits that no one of ordinary skill in the art would be lead to believe that Tan's electroplating process would have a discontinuous seed layer, because to do so would render the invention non-functional. Thus, as asserted by Applicant in previous amendments and responses, the Tan reference is inappropriate since it does not disclose or suggest a discontinuous or thin seed layer for electroless plating. To render this point even more distinctly clear, Applicant has amended claims 7, 8, 13, 20, 21, 28 and 34 herein to recite a discontinuous seed layer.

The Examiner states in the second paragraph of section 7 on page 6, that the "discontinuous seed layer is taught by Matsuda (see Figs. 1-5, 7A, 7B). In Matsuda the seed layer forms discontinuous islands." Applicants submit that the Examiner is incorrect is stating that "the seed layer 56 is used for the rejection (see col. 7, lines 1-7)", and submit that one of ordinary skill in the art would understand that the "copper film 56 is formed as the second metal film" of the plating layer made up of the two films 55 and 56, since in the disclosed method "a copper film 57 is formed as the third metal film by electroplating or electrolessplating" (col. 7, lines 8-9), and electroplating requires a continuous conductive film to spread the electrical current to all portions of the wafer. The stated purpose of the discontinuous copper film 56 is to form a "copper film 57 having a large crystal grain size" (col. 7, line 10) to "provide good electromigration resistance". The disclosed the lower portion of the seed layer is described and shown as continuous and forming a diffusion barrier layer. Thus Applicant submits that one of ordinary skill in the art would understand that such a disclosed arrangement could not be discontinuous without rendering the device non-functional.

The Examiner has the burden of establishing a prima facie case of obviousness under 35 USC § 103(a), and the test is whether one of ordinary skill in the art, with the suggested references in front of him, would be motivated to make the proposed combination. Applicant respectfully submits that one of ordinary skill in the art would understand that the barrier layer 14, described in Tan as being of titanium-tungsten or of titanium-tungsten nitride, is not a discontinuous seed layer, for the reasons given above and in the previous response. Thus the Office Action fails to show motivation to combine the cited documents.

The Office Action uses the Matsuda reference to show that electroless plating, the thickness and the discontinuity of the seed layer are known in the art. Applicant respectfully submits that one of ordinary skill in the art would understand that Matsuda discloses a continuous metal film barrier layer with islands of a different metal formed on the surface of the first metal to act as nucleation sites, and not a discontinuous seed layer. Thus the Office Action fails again to show motivation to combine the cited documents.

Applicant respectfully submits that since both reference describe a continuous metal layer, then neither document could describe or suggest a discontinuous seed layer on a semiconductor substrate. Applicant further submits that since the references neither describe nor suggest at least the feature of electroless plating to a top surface of a photo resist layer, or describe or suggest using the first photo resist 20 as part of the plating mask. Therefore, Applicant respectfully submits that the Office Action fails to provide the required showing of motivation to combine the cited documents, and further, even if the combination were made it would still result in a different structure from the claimed arrangement.

Specifically, independent claim 8 is patentable over any combination of the cited documents, Tan and Matsuda, because the suggested combination of documents neither describes nor suggests at least the claimed feature of “...*depositing a discontinuous seed layer including a thin film of Palladium (Pd) or Copper (Cu) having a discontinuous island structure ... depositing a layer of copper over the seed layer using electroless plating ...*”, as recited in claim 8, as amended herein. As discussed in depth above, the cited documents have a continuous metal film and not a discontinuous seed layer. Claims 9-12 depend from claim 8 and are thus in patentable condition at least as reciting additional limitations over a patentable base claim. Applicant respectfully request that this rejection be withdrawn. Independent claim 34, as amended herein, is held to be patentable over the suggested combination of references for similar reasons. Dependent claims 35-37 are held to be in patentable condition at least as depending from a patentable base claim. In view of the above discussion, Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 3, 5, 7, 12, 38-42, and 65 were rejected under 35 USC § 103(a) as being unpatentable over Tan in view of Matsuda and Naik et al. (U.S. Patent No. 6,245,662). Applicant respectfully traverses this rejection.

The features of the cited Tan and Matsuda references have been discussed above with reference to the previous rejections. The outstanding Office Action uses the Naik reference to show that oxygen plasma ashing of photoresist is known. Naik discloses a method of forming a via in a single step that includes a first dielectric layer, an etch stopper layer and a second dielectric layer. Naik suggests that another passivation layer should be used to prevent copper corrosion.

Applicant submits that independent claim 7, as amended herein, is patentable over any combination of the cited references, because the suggested combination neither describes nor suggests at least the claimed feature of “...*depositing a discontinuous seed layer including a thin film of Palladium (Pd) or Copper (Cu)... depositing a layer of copper over the seed layer using electroless plating; and removing the photoresist layer and exposed portions of the seed layer using oxygen plasma ashing...*”, as recited in claim 7. As noted above the references have a continuous metal layer between the electroless plated copper and the substrate, and the corrosion suggested by the Naik reference would not suggest using plasma ashing to remove exposed portions of the seed layer to one of ordinary skill in the art. A similar argument obtains for independent claims 8 and 34, not rejected here. Dependent claims 3, 5 and 65 are held to be in patentable condition at least as depending from claim 7, shown above to be patentable over the suggested combination of references. Dependent claims 12 and 38-42 are held to be in patentable condition at least as depending from claims 8 and 34 respectively, shown above to be patentable over the suggested combination of references. In view of the above reasons Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 5, 11, and 13-33 were rejected under 35 USC § 103(a) as being unpatentable over Tan in view of Matsuda or Tan in view of Matsuda and Naik and Andricacos et al. (U.S. Patent No. 5,937,320). Applicant respectfully traverses this rejection.

The features of the cited Tan, Matsuda and Naik references have been discussed above with reference to the previous rejections. The outstanding Office Action uses the Andricacos

reference to show that plating to the top of a photoresist layer is known. Applicant submits that the addition of the Andricacos reference does nothing to correct the deficiencies of the suggested combination of the Tan, Matsuda and Naik references.

Specifically, Applicant submits that independent claim 7, as amended herein, is patentable over any combination of the cited references, because the suggested combination neither describes nor suggests at least the claimed feature of “...*depositing a discontinuous seed layer including a thin film of Palladium (Pd) or Copper (Cu)...* *depositing a layer of copper over the seed layer using electroless plating; and removing the photoresist layer and exposed portions of the seed layer using oxygen plasma ashing...*”, as discussed above with reference to the previous rejection. Similar reasons obtain for independent claims 8, 13, 20 and 28, specifically that the suggested combination, even if allowable, still does not disclose or suggest a discontinuous plating layer, or using plasma ashing to remove the photoresist and seed layer, or to plate to the top of the photoresist layer. Dependent claims 5, 11, 14-19, 21-27, and 29-33 are held to be in patentable condition at least as depending from base claims shown above to be patentable over the suggested combination of references. In view of the above reasons Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 13-42 were rejected under 35 USC § 103(a) as being unpatentable over Tan, Matsuda and/or Naik and/or Andricacos in view of Simpson (U.S. Patent No. 6,197,688). Applicant respectfully traverses this rejection.

The features of the cited Tan, Matsuda, Naik and Andricacos references have been discussed above with reference to the previous rejections. The Office Action uses the Simpson reference to supply the missing features of the suggested combination of references of forming conductive vias and then forming conductive lines. Applicant submits that the cited reference of Simpson does not remedy the above noted failing of the combination of Tan, Matsuda, Naik or Andricacos. Simpson discloses a method which does not use photoresist as the plating mask, nor does Simpson plate to the top of the masking layer, as would be clear to one of ordinary skill in the art from the use of chemical mechanical polishing (CMP).

Specifically, Applicant submits that independent claim 13, as amended herein, is patentable over any combination of the cited references, because the suggested combination neither describes nor suggests at least the claimed feature of “...*depositing a first discontinuous seed layer including a thin film of Palladium (Pd) or Copper (Cu) on a semiconductor substrate; depositing a first patterned photoresist layer, wherein depositing the first patterned photoresist layer defines a first number of via holes above the first seed layer; forming a first layer of copper using electroless plating, wherein forming the first layer of copper vias using electroless plating includes filling the first number of via holes to a top surface of the first patterned photoresist layer...*”, as recited in claim 13, as amended herein. The reasons are similar to those given above with reference to the previous rejection, and obtain for independent claims 20, 28 and 34 as well, specifically that the suggested combination, even if allowable, still does not disclose or suggest a discontinuous plating layer, or using plasma ashing to remove the photoresist and seed layer, or to plate to the top of the photoresist layer. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Applicant further incorporates all prior responses to preserve all issues for any future appeal of this application.

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney, David Suhl, at (508) 865-8211 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

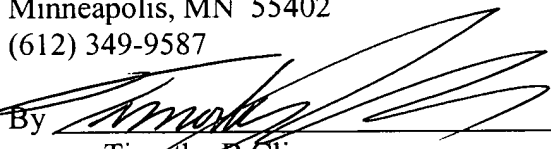
Respectfully submitted,

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